ness. Nevertheless, the probability of such conceptions having had real counterparts in the material world is absolutely *nil*, so far as experience shows, and for like reason we can ascribe only a mythical existence in times past to warm-blooded reptiles, feathered reptiles, or reptiles possessing so eminently bird-like a characteristic as the *gizzard*.

It is, therefore, surprising to find a writer in SCIENCE (No. 501, p. 185) advancing the anomalous conception of reptiles with organs corresponding to the avian gizzard. The solitary fact upon which Mr. Barnum Brown bases his conclusion is the discovery, in a number of instances, of small-sized silicious pebbles in association with plesiosaur skeletons from the western Cretaceous. Certain corollary assumptions, apparently accepted as axiomatic by Mr. Brown, but nevertheless debatable, may be stated as follows:

(1) These 'stomach stones' were contained within the alimentary canal prior to the death of the creatures, and not accidentally deposited upon or with their remains. (2) The stones were intentionally swallowed, and not taken promiscuously with other fare, as might happen in bottom-feeding. (3) They served as a mechanical aid to digestion through the intervention of a supposititious gizzard-like organ. (4) Thin-shelled prey like cephalopods could not have been crushed upon one another without the admixture of a judicious quantity of 'stomach stones.' (5) The non-occurrence of such stones amongst European reptiles proves only that the latter 'had no stomach' for them, not that they were gizzardless. (6) The history of the gizzard (*horresco referens*) shows that it was developed first amongst cold-blooded vertebrates, then lost by them, and afterwards independently acquired by birds. Incidentally it appears that plesiosaurs possessed the most highly specialized digestive apparatus known amongst reptiles, ancient or modern.

For our part, begging pardon of Mr. Brown, we are willing to consign to birds the exclusive enjoyment of gizzards and feathers. A cogent reason for suspending judgment as to the function of 'stomach stones' is found in their limited distribution. Before asking us to believe that all plesiosaurs had 'gizzard-like arangements' (*sic*), let it be shown that all plesiosaurs and related reptiles had the habit of gorging themselves with foreign matter to the extent asserted of American species, and let no doubt remain that these pebbles are not of adventitious origin.

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TO THE EDITOR OF SCIENCE: In SCIENCE for August 5, 1904, at page 184, mention is made of the stones often found apparently in the stomachs of fossil plesiosaurs, with the suggestion that they may be connected with the food habits of the animals with whose remains they are associated. It is of interest to notice that, according to Mr. Hornaday, the stomachs of the west coast sea lions contain rounded pebbles an inch or two in diameter. As their food seems to be somewhat similar to that of the extinct plesiosaurs, a careful study of the sea lion's habits may be of importance to paleontology.

JULIUS HENDERSON.

SPECIAL ARTICLES.

DETERMINATION OF LONGITUDE.

THE recent determination of the difference of longitude between San Francisco and Manila by the use of the cables of the Commercial Pacific Cable Company, by the Coast and Geodetic Survey completed the longitude girdle of the earth, and the results will be published in detail in the 'Report of the Superintendent of the Coast and Geodetic Survey,' for 1904. In anticipation of that report the results are now made public by the authority from the superintendent.

The parties in charge of Assistants Edwin Smith and Freemont Morse started for the field in March, 1903, and finally completed the field work in May, 1904. The distance by cable from San Francisco to Manila (7,847 nautical miles) is covered by four cables extending from San Francisco to Honolulu, Honolulu to Midway Island, Midway Island to Guam Island and Guam Island to Manila. For the purpose of exchanging time signals, the Commercial Pacific Cable Company very generously gave the use of the cables to the survey free of charge and at all the stations extended to the

field parties courtesies and assistance without which the execution of the work would have been impracticable. This was specially the case at Guam and Midway Islands, where the parties were almost wholly dependent upon the cable staffs. The transportation to and from these islands is very infrequent and was the cause of the long delay in the completion of the field work.

In the determination of time at the several stations the method set forth in Appendix 7, of the 'Coast and Geodetic Survey Report,' for 1898 was carried out except that it was impossible to observe the same stars at both stations involved in each determination of a difference of longitude, on account of the great difference of longitude and also the unfavorable weather conditions which often necessitated the observation of different stars on consecutive nights. The stars were selected almost exclusively from the list given in the *Berlin Jahrbuch,* and it is believed that the results must be very little if any in error on account of errors of the right ascensions.

The greatest difficulty to be overcome was the eliminations of the difference of personal equation of the observers.

Since 1891, the Germans have used the Repsold registering micrometer on their transits and their experienced observers seem to have almost no personal equation in its use for the determination of time.

In eight differences of longitude determined by them, 1893 to 1903, an exchange of instruments and observers took place midway in the work of each determination, thus giving a determination of the sum of the differences of instrumental and personal equations.

The following results are taken from the *Astronomisch-Geodatische Arbeiten* of the Preussischen Geodatischen Institutes for 1902 and 1904.

		s
	1893	
Ubagsberg-Göttingen	III. Borrass—II. Albrecht	—0.009
Ubagsberg-Bonn	" "	— 0.019
Bonn-Göttingen	" "	— 0.034
	1898	
Knivsberg-Kopenhagen	III. Albrecht—II. Schumann	— 0.034
Knivsberg-Kiel	" "	— 0.033
	1900	
Potsdam-Burkarest	III. Albrecht—II. Borrass	— 0.017
	1901	
Potsdam-Pulkowa	III. Albrecht—II. Borrass	— 0.025
	1903	
Potsdam-Greenwich	III. Albrecht—II. Wanach	0.000

Had no exchange of place of instruments and observers been made, the errors in the differences of longitude due to personal equation would in no case have been greater than 0.034.

The addition of registering micrometers to the transit of the Coast and Geodetic Survey was considered, but this was found quite impossible in time for the trans-Pacific work.

An exchange of observers took place between San Francisco and Honolulu and difference of personal equation was determined by special observations as often as the observers met. The results are here given. The plus sign means that S observes later than M.

From the exchange of observers between San Francisco and Honolulu, April 20–29 and June 2–13, 1903.

$$S-M=+0^{s}.062\pm0^{s}.008.$$

The following are the results from the ten special nights observation:

Locality.	Date.	Stars.		s	s	Wt.
San Francisco	March 28, 1903	20	$S-M=$	+0.085	±0.017	0.7
" "	April 1, 1903	20		+0.092	±0.017	0.7
Honolulu	May 11, 1903	20		+0.109	±0.010	1.0
"	June 27, 1903	20		+0.106	±0.012	0.8
"	April 18, 1904	20		+0.060	±0.009	1.1
"	April 21, 1904	17		+0.079	±0.007	1.4
San Francisco	May 6, 1904	22		+0 075	±0.013	0.8
" "	May 7, 1904	26		+0.045	±0.012	1.0
" "	May 8, 1904	22		+0.043	±0.015	0.8
" "	May 9, 1904	26		+0.087	±0.015	0.8

The mean of the ten nights is:

$$S-M=+0^{s}.077\pm0^{s}.005.$$

This result with an assigned weight of 2.0 combined with that determined from the exchange of observers between San Francisco and Honolulu with an assigned weight of 1.3 gives

$$S-M=+0^{s}.077\pm0^{s}.007.$$

This personal equation is applied to the differences of longitude between Honolulu-Midway, Midway-Guam, Guam-Manila. The difference of longitude between San Francisco and Honolulu is corrected by the personal equation determined from the exchange of observers only. The range of these results is no greater than should be expected from the computed probable errors and may, therefore, be due to errors of observation rather than to

variation of personal equation. The observers were so placed that personal equation is eliminated in the final longitude of Guam and enters only once in the final longitudes of Midway and Manila. It does not seem that these longitudes can be seriously in error on account of personal equation.

A method of automatically recording time signals over long cables had been successfully used by the Canadian and English observers in the determination of the difference of longitude between Greenwich and Montreal in 1892, but no description of this method was available. A visit was made to the office of the Commercial Cable Co., at New York, where information was obtained which led to the designing and construction at the Coast and Geodetic Survey office, of an apparatus for recording automatically time signals over the cables.

The instrumental outfits of the five stations of the Commercial Pacific Cable Co. are similar. The Muirhead Syphon Recorders are exclusively used, and a description of them can be found in 'Submarine Telegraphs' by Charles Bright. The record is made upon a slip of paper by a syphon pen attached by two fibers to the coil of the recorder. The slip of paper is made to move by an electric motor at the rate of about two centimeters per second. In order that the paper and pen may be adjusted to the proper relation the rollers over which the paper passes are attached to a stand capable of a vertical and two horizontal adjustments. It was necessary that all cable signals should be recorded on this slip of paper at the cable office. The problem was to refer the record of a signal received over the cable to the time as recorded by a break-circuit chronometer. It was solved in the following manner. To the armature of a twenty-ohm Morse relay was attached an arm of aluminum, which carried a syphon pen exactly like the one on the cable receiver. This relay was mounted on a stand capable of a vertical and two horizontal adjustments. This was called the chronometer cable recorder. It could be placed on the table in front of the cable receiver and so adjusted that its syphon pen would record on the slip of paper parallel to the record made by the pen of the cable recorder. The chronometer and battery being put in circuit with the chronometer cable recorder, a record of the chronometer seconds was made on the slip and any signal coming over the cable was recorded by the pen of the cable recorder also on the slip. This cable signal could be brought vertically down to the record of the chronometer and its time read off by the usual scale. On account of the impracticability of always adjusting the pens exactly opposite each other, the cable signal has a correction, the determination of which will presently be explained. Signals were sent by a key such as is used in correspondence over the cable. It is a double key by which a positive or negative current can be sent to the cable. An attachment was made to these keys at the Coast and Geodetic Survey office by which the circuit through the chronometer recorder would be broken the instant the current was put on the cable and thus record the chronometer time of the signal sent. When sending signals the local cable receiver is generally disconnected, but by so arranging a shunt that a small portion of the sending current would pass through the coil of the local receiver a sharp record was also made by the pen of the cable receiver and thus the relation of the two pens was obtained.

At the stations San Francisco, Honolulu and Manila the observatories were so far from the cable office that the chronometer cable recorder at the cable office could not be placed in circuit with the chronometer at the observatory. Another chronometer was, therefore, placed at the cable office to be used in the exchange of the cable signals. At these stations the cable offices and observatories were connected by land lines by which the two chronometers were compared before and after the exchange of cable signals. At Midway and Guam the cable offices and observatories were only a few hundred feet apart, so that the chronometer cable recorder at the cable office could be placed directly in circuit with the chronometer at the observatory and no comparisons of local chronometers was necessary. The results indicate that time signals over long cables can now be exchanged with as great accuracy as over the best land lines.

By the transmission time of a signal over a cable is meant the time that elapses from the instant the record is made on the slip at the sending station to the instant the record is made on the slip at the receiving station. These times as determined from sending signals in both directions over the four cables are given in the last column of the following table. The other data in the table have been kindly furnished by Mr. G. G. Ward, the vice-president and general manager of the cable company.

	Diameter of Copper Conductor.	Length of Cable in Nautical Miles.	Resistance of Copper.	Electromotive Force used.	Transmission Time.
	Inch.		Ohms.	Volts.	s
San Francisco-Honolulu	0.1801	2 276 3	5,054	50	0.189
Honolulu-Midway	0.1122	1 332.0	6,530	30	0.118
Midway-Guam	0.1830	2,606.9	4,758	50	0.195
Guam-Manila	0.1183	1,631.6	7,235	35	0.156

The following are the differences of longitude corrected for personal equation as determined over these four cables:

	h	m	s s
San Francisco-Honolulu	2	21	38.919 ± 0.008
Honolulu-Midway	1	18	03.219 ± 0.015
Midway-Guam	2	31	53 584 ±0.010
Guam-Manila	1	34	43.263 ± 0.010

The San Francisco station is $8^h\ 9^m\ 48^s.813 \pm 0^s.056$ west of Greenwich (see 'The Longitude Net of the United States and its Connection with that of Europe, 1866–1896,' Appendix 2, Coast and Geodetic Survey Report, 1897, and also 'The Transcontinental Triangulation,' pp. 820 and 826, Coast and Geodetic Survey Special Publication, 1900). The Manila station is $0^s.224$ west of the dome of the Manila Cathedral, which is the accepted point of reference in Manila. Combining these with the above differences of longitude, we have the following longitudes:

	h	m	s s
Honolulu Transit west of Greenwich	10	21	27.752 ± 0.05
Midway Transit west of Greenwich	11	49	30.951 ± 0.057
Guam Transit east of Greenwich	9	38	35.465 ± 0.058
Manila Cathedral dome east of Greenwich	8	03	52.425 ± 0.059

Comparisons with former determinations of the longitudes of the several stations.

Honolulu.—In a former issue of this paper* an elaborate discussion of former determinations of the longitude of Honolulu was given by Mr. J. F. Hayford, of the Coast and Geodetic Survey, to which the reader may refer. We will give here only the most reliable one. In 1874 Captain G. L. Tupman, Royal Marine Artillery in charge of the British Transit of Venus Expedition of that year, determined the longitude of his station by seven results from occultations of stars by the moon, fifty-two results from observations of moon culminations and sixty results from the observations of zenith distances of the moon combined with the observed culminations and zenith distances of well-known stars. His result officially communicated to the Hawaiian government is $10^h\ 31^m\ 27^s.2$.

* November 6, 1903.

The longitude determined by the Coast and Geodetic Survey by the cables referred to the same point is $10^h\ 31^m\ 27^s.236$, a remarkably close agreement.

Midway Islands.—These islands were discovered by Capt. N. C. Brooks in the *Gambia,* July 5, 1859. In 1867 Capt Reynolds, U.S.N., in the *Lackawana,* visited the islands and gave the longitude of the north point of the larger island as:

Longitude 177° 18′ 20″ west.
h m s
11 49 13.3

In 1900 a survey was made of the islands by the officers of the U. S. S. *Iroquois,* under the command of Lieut. Commander C. F. Pond. The Hydrographic Office Chart No. 1951 is based upon this survey and the longitude given for the point marked Observation Spot is:

Longitude 177° 21′ 30″ west.
h m s
11 49 26 west.

The longitude determined by the Coast and Geodetic Survey by the cables referred to the same point is:

Longitude 177° 22′ 46.″4 west.
h m s
11 49 31.091 west.

Guam Island.—In 1819 M. de Freycinet in the French corvettes *L'Uranie* and *La Physicienne* made a survey of the southern part of the Mariana or Ladrone Islands and gave the longitude of Fort Santa Cruz in the harbor of San Luis D'Apra, Guam Island, as:

144° 39′ 45″ east.
h m s
9 38 39 east.

(See Findley's 'North Pacific Directory,' p. 800.)

In 1875 the island was visited by Capt. Knorr, of the German Navy, in the ship *Hertha*. The longitude of Fort Santa Cruz was determined to be:

144° 39′ 30″ east.
h m s
9 38 38 east.

See *Annalen Hydrographie*, 1875, p. 284, and also of geographical positions compiled by Lieut. Commander Green and published by the Hydrographic Office, U. S. N., 1883.

In 1899 the officers of the U. S. S. *Yosemite* made a survey of the harbor of San Luis D'Apra. They built a concrete pier on Fort Santa Cruz and determined its longitude by transit observations and the transportation of chronometers back and forth from Yokosuka, Japan. The longitude of this pier as communicated by the hydrographic office is:

Longitude 144° 39′ 21″ 45 east.
h m s
9 38 37.43 east.

The longitude determined by the Coast and Geodetic Survey by the cables referred to the same point is:

Longitude 144° 39′ 42″.15 east.
h m s
9 38 38.81 east.

Manila.—Two former telegraphic determinations of the longitude of Manila can be deduced, one *viâ* Madras, India, and the other *viâ* Vladivostock, Siberia.

The longitude of Madras has been determined by five independent series of observations and a résumé of them has been given by Capt. Burrard in Appendix No. 2, Vol. XVII., of the 'Great Trigonometrical Survey of India.' They are as follows:

	h m s	s	
Series *A*	5 20 59.750	± 0.155	1874–5 and 1881–2.
B	5 20 59.010	± 0.163	1874.
C	5 20 59.137	± 0.022	1876, 1881, 1892–4–5.
D	5 20 59.223	± 0.127	1874–7.
E	5 20 59.421	± 0.123	1884–7.

Series *A* is *viâ* Pulkowa, Moscow and through Siberia to Vladivostok by the Russians and thence to Madras by the U. S. Navy. As the series will be used for the deduction of the longitude of Manila direct, it will not be considered in the determination of the longitude of Madras.

Series *B*, *D* and *E* were mostly determined by the parties who went out to observe the transit of Venus in 1874, and it is stated that the observations were not conducted with the refinement necessary for the determination of fundamental longitudes. It therefore seems at the present that series *C* must be considered the only reliable determination of the longitude of Madras. It is made up of ten differences of longitude in which personal equation was eliminated by the exchange of observers or by special observations. The observers were also so placed that in the final longitude of Madras personal equation would be eliminated. One link in this series is the difference of longitude between Potsdam and Greenwich and this was redetermined in 1903 by the Germans in most refined manner and the result increases the longitude of series *C* by $0^s.098$. This increased result will be used in the deduction of the longitude of Manila.

The difference of longitude between Pulkowa-Greenwich was redetermined by two steps, Pulkowa-Potsdam and Potsdam-Greenwich, by the Germans in 1902–3. This work supersedes the older determinations and will be here used. The difference of longitude Vladivostok-Pulkowa is made up of thirteen differences of longitude by the Russians. In all the work between Vladivostok and Greenwich personal equation was eliminated as in the case of Madras.

In 1881–2 the differences of longitude of Vladivostok-Manila and Manila-Madras was determined by officers of the U. S. Navy. The entire work consists of ten differences of longitude. Seven of them are involved in the difference of longitude Vladivostok-Manila and four in the difference of longitude Manila-Madras. In this work the differences of longitude are not corrected for personal equation and no information as to the value of personal equation of the observers that can now be used can be found. The endeavor was made to so place the observers that personal equation would be eliminated as far as possible in the

resulting longitudes. The difference of longitude Vladivostok-Manila remains uncorrected for plus the difference of personal equation of two of the observers, and the difference of longitude Manila-Madras remains uncorrected for plus twice the difference of personal equation of the same two observers. The two results for the longitude of Manila are as follows:

1.

	h m s	s
Manila Cathedral Dome-Madras, U. S. Navy,	2 42 53.000	± 0.057 + 2 (*N*-*G*.)
Madras-Greenwich, English and Germans,	5 20 59.238	± 0.022
Manila Cathedral Dome-Greenwich,	8 03 52.238	± 0.061 + 2 (*N*.-*G*.)

2.

	h m s	s
Vladivostok-Manila Cathedral Dome, U. S. Navy,	0 43 38.500	± 0.059 + (*N*.-*G*.)
Vladivostok-Greenwich, Russians and Germans,	8 47 31.197	± 0.146
Manila Cathedral Dome-Greenwich,	8 03 52.697	± 0.157 — (*N*.-*G*.)

The symbol (*N*.-*G*.) indicates the unknown personal equation correction to these determinations of the longitude of Manila. Owing to this unknown correction, it is difficult to give proper weights to these two values of the longitude of Manila to combine them with the value recently determined by the Coast and Geodetic Survey *viâ* United States. It is probable that the value of (*N*.-*G*.) is plus and the corrections, if known, would bring the two longitudes of Manila closer together. Taking the mean of the two values, we have:

	h m s
Manila Cathedral Dome-Greenwich	8 03 52.468 + $\frac{1}{2}$ (*N*.-*G*.).

which differs only $0^s.042$ or 61.7 feet from the Coast and Geodetic Survey result.

In 1881–2 the U. S. Navy adopted for the longitude of Madras $5^h\ 20^m\ 52^s.42$, which gave for their value of the longitude of Manila $8^h\ 03^m\ 52^s.42$. This value, which differs only $0^s.006$ or 8.8 feet from the Coast and Geodetic Survey result, has been used since 1882.

The difference of longitude San Francisco-Manila determined by the Coast and Geodetic Survey has a probable error of ± 0.022. The longitude of San Francisco depends upon the longitude net of the United States and its connection with that of Europe, and includes seventy-two differences of longitude between forty-five points. Four of these differences of longitude are trans-Atlantic, three by the Coast and Geodetic Survey and one (1892, not yet published) by the English and Canadians. In view of these facts and the unknown correction for personal equation in the other two values of the longitude of Manila, the value determined by the Coast and Geodetic Survey will be accepted. EDWIN SMITH.

COAST AND GEODETIC SURVEY,
September 2, 1904.

BOTANICAL NOTES.

SYSTEMATIC NOTES.

Two new blackberries (*Rubus vermontensis*, and var. *viridifolius*), allied to *Rubus argutus*, are described by W. H. Blanchard in the July number of the *American Botanist*. They occur in southern Vermont.—The July number of the *Fern Bulletin* contains an annotated list of the ferns of Kentucky by the late Miss S. F. Price. Thirty-eight species of ferns and four lycopods are included.—Professor E. L. Greene continues the publication of his 'Leaflets,' the last fascicle (pages 49–64) bearing date of August 25, 1904, and including systematic discussions pertaining to *Cactaceae, Gentianaceae, Apocynaceae, Cichoriaceae* and *Rhamnaceae*.—In the August number of *Torreya* Dr. N. L. Britton describes a new alder (*Alnus noveboracensis*) from Staten Island.—Mr. C. G. Lloyd's 'Mycological Notes' for June include some interesting paragraphs in regard to the herbaria of Kew, the British Museum, Linnaean Herbarium, Leiden and Berlin, as well as personal notes about some of the botanists now or formerly associated with these collections.—Mr. E. P. Bicknell continues his studies of *Sisyrinchium* in the June *Torrey Bulletin*, describing five new species from California. In the same journal Dr. P. A. Rydberg describes twenty-five new species and varieties of flowering plants from the Rocky Mountain region.—W. A. Murrill continues his series of papers on the *Polyporaceae* of North America in the August *Torrey Bulletin*, and separates the following new genera from *Polyporus*, viz., *Abortiporus*, *Cyclomy-*